



## INTEROFFICE CORRESPONDENCE

DATE: November 24, 1993

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FROM: S. P. Needler, Environmental Engineering & Technology, Bldg. 080, X6961

SUBJECT: IMPLEMENTATION OF METHODOLOGY FOR CONDUCTING SITE-TO-BACKGROUND  
STATISTICAL COMPARISONS - SPN-116-93

This memo transmits a methodology for doing site-to-background statistical comparisons which has been submitted to the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Colorado Department of Health (CDH) for approval. EG&G will be following the attached methodology for all future OU site-to-background comparisons. Specific software packages mentioned are used for purposes of example only, and are not required.

There has been a longstanding dispute between EG&G, DOE, EPA, and CDH about the proper methodology for performing site-to-background comparisons. To resolve the dispute, Dr. Richard Gilbert was invited to arbitrate. He wrote a proposal to EPA on July 30, 1993, consisting of a battery of tests for performing statistical comparisons. EPA and CDH requested that DOE and EG&G provide a specific methodology incorporating Dr. Gilbert's proposal. This was submitted to DOE on November 19. The attachment to this memo summarizes that methodology.

No response is required. Copies of the applicable sections of references cited will be forthcoming. Please direct questions or comments to Steven Needler at X6961 or DP7579.

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## METHODOLOGY

First, graphs are plotted to get a "look" at the site and background data. Then, five separate tests are performed to compare the site to background data. After all five tests are performed, the results of the tests and plots are analyzed using the professional judgement of a geoscientist, and possibly a statistician, on an analyte-by-analyte basis.

**Plots:** Box plots and histograms will be performed when the percentage of detects is at least 50%. Bars in the histogram will be shaded to indicate detects and non-detects. Additional graphics are not required, but can be done if considered appropriate by the analyst and OU manager. Software for performing the box plots and histograms are available from standard statistical software packages. For example, SAS can be used (BOXCHART statement in a SHEWHART procedure, and a HISTOGRAM statement with a PROCESS CAPABILITY statement).

**Tests:** There are two statistical tests that are always performed (and an additional three tests, which are run unless a statistician does not consider them applicable). Prior to all the tests except the Gehan, non-detects should be replaced with values equal to  $1/2 \times$  (the detection limit for that particular reading). The Gehan test does not require non-detect replacement.

1. **Hot-Measurement Test.** The hot-measurement test calculates an upper tolerance limit  $UTL_{99/99}$  from the background data using the formula obtained from EPA (1992). These  $UTL_{99/99}$  values are available from Mary Siders for standard background media. Then individual site analyte values are compared to the  $UTL_{99/99}$ , and if any site values exceed the  $UTL_{99/99}$ , the test result is positive (i.e., the site has a significantly higher concentration of that analyte than background).
2. **Gehan or Nonparametric ANOVA Test.** The Gehan test was developed locally by the RFP Statistical Applications (SA) group. The SAS-executable code is available either from Denny Weier of SA or from Steven Needler. If the Type I error rate is less than 0.05, then the test is positive for the analyte being considered to be a pCoC.

Alternatively, standard nonparametric ANOVA tests (Wilcoxon Rank Sum or Kruskal-Wallis) may be used in place of the Gehan test. The Wilcoxon Rank Sum and Kruskal-Wallis tests are standard in statistical software. They can be accessed in SAS through the RANK procedure. If the Type I error rate is less than 0.05, then the test is positive for the analyte being considered to be a pCoC.

3. **Quantile Test.** This test is applicable only if less than 20% of the data are non-detects. Two values,  $r$  and  $k$ , are obtained from tabulated values in Gilbert and Simpson (1992). All the readings, background and OU, are then listed together, from highest to lowest value. If there are at least  $k$  OU readings in the  $r$  largest values, then this test is positive for the analyte being considered to be a pCoC.
4. **Slippage Test.** This test is applicable if the largest background data point is a detect. If the largest background data point is a non-detect, this test may still be applicable if professional judgement can compensate for the largest background data point. The professional judgement would be supplied by a statistician, supported by a geoscientist. The test simply counts the number,  $K$ , of OU measurements that exceed the maximum background measurement, and then

seeing whether K exceeds the critical value from the tables in Rosenbaum (1954); if so, this test is positive for the analyte being considered to be a pCoC.

5. T-Test. This test is applicable only if the data are normally distributed, if less than 20% of each of the background and site data are non-detects, and if there are at least 20 data points in the background and site populations. The t-test can be accessed in Excel as PTTESTV, and in SAS as an option in the UNIVARIATE option, and is available on other software. If the Type I error rate is less than 0.05, then the test is positive for the analyte being considered to be a pCoC.

References:

EPA, July 1992. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance*.

Gilbert, R. O., and Simpson, J. S. December 1992. *Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 3: Reference-Based Standards for Soils and Solid Media*, PNL-7409 Vol. 3, Rev. 1, Pacific Northwest Laboratory, Richland, Washington.

Rosenbaum, S. 1954. Tables for a Nonparametric Test of Location. *Annals of Mathematical Statistics* 25:146-150.